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PRESSURE ELECTROLYZER AND CELL FRAME  
FOR SAID ELECTROLYZER

The invention concerns a pressure electrolyzer in accordance with the introductory clause of Claim 1 and a cell frame for said electrolyzer in accordance with the introductory clause of Claim 11.

Pressure electrolyzers for the electrolytic cleavage of water into hydrogen and oxygen are known which have a pressure tank and a block of electrolytic cells, which is arranged in the pressure tank and contains a number of electrolytic cells combined in the form of a stack. Each electrolytic cell contains an anode and a cathode. An electrolytic fluid or electrolyte circulation system serves to supply an anolyte to the anodes and a catholyte to the cathodes. The electrolytic cell block has a sealed housing, by which it is sealed from the interior of the pressure tank. A pressure electrolyzer of this type is described in DE 25 48 699 C3.

Expensive devices that contain spring elements, a support frame, and similar components are usually necessary for tensioning and sealing the individual cells of the electrolytic cell block against one another. The power supply system for the electrolytic cell block has previously consisted of a large number of parts, including a pressure pipe, gaskets, etc.

The objective of the invention is to create an improved pressure electrolyzer, specifically, a pressure electrolyzer that has a simpler design and is constructed with a smaller number of parts and can thus be manufactured at low cost. A further objective is the creation of a cell frame for the construction of the electrolytic cell block.

These objective are achieved, on the one hand, by a pressure electrolyzer with the features of Claim 1 and, on the other hand, by a cell frame for a pressure electrolyzer with the features of Claim 11.

Advantageous modifications are specified in the dependent claims.

The invention creates a pressure electrolyzer with an electrolytic cell block that contains a number of electrolytic cells combined in the form of a stack. Each electrolytic cell contains an anode and a cathode. The electrolytic cell block has a sealed housing. End plates are mounted at the ends of the electrolytic cell block. In accordance with the invention, the housing of the electrolytic cell block is formed by a number of stacked cell frames. The cell frames consist at least partially of a material that is elastic at least in the longitudinal direction and the transverse direction of the electrolytic cell block and seals adjacent cell frames from each other. The electrolytic cell block is held in place between the end plates under compression of the elastic material in the longitudinal direction. An advantage of the pressure electrolyzer of the invention is that thermal expansion of the individual electrolytic cells and thus of the entire electrolytic cell block is compensated by the elastic material provided in the cell frames. On the one hand, this makes it possible to provide the end plates in stationary form in a simplified way, for example, in the form of tank covers of a pressure tank surrounding the electrolytic cell block. On the other hand, additional devices for keeping the electrolytic cell block under a well-defined pretension in all temperature ranges can be dispensed with. In addition, relatively large manufacturing tolerances of the electrolytic cells and the cell frames can be compensated by the elastic material.

Preferably, the cell frames can have a rigid element, which runs in the circumferential direction of the frame for mechanical stabilization of the cell frames and is connected with the elastic material.

In accordance with one embodiment of the invention, the rigid element can form a shell-like frame structure, which partially encloses the elastic material and from which the elastic material partially protrudes to form a compressible region in the longitudinal direction of the electrolytic cell block.

In accordance with another embodiment of the invention, the rigid element can form a frame-like insert that is wholly or partially embedded in the elastic material.

In accordance with a modification of the invention, adjacent cell frames can each have projecting parts and recesses that fit into each other for locking the adjacent cell frames in place and/or for sealing the adjacent cell frames.

In accordance with a preferred embodiment of the invention, each anode can have its own anode cell frame, and each cathode can have its own cathode cell frame.

The elastic material can consist of an elastomer or a soft elastic thermoplastic.

The rigid element can consist of a dimensionally stable material, especially a metal or a plastic.

The rigid element that forms the shell-like frame structure can consist of an electrically insulating material, especially plastic.

In addition, the invention creates a cell frame for a pressure electrolyzer with the aforementioned features.

Specific embodiments of the invention are explained below with reference to the drawings.

-- Figure 1 shows a schematic cutaway top view of a pressure electrolyzer in accordance with one embodiment of the invention.

-- Figure 2 shows an enlarged cutaway view of a portion of the cell frames of the electrolytic cells, which simultaneously form a sealed housing of the electrolytic cell block in accordance with one embodiment of the invention.

-- Figure 3 shows a cutaway view, similar to Figure 3, of another embodiment of the invention.

-- Figure 4 shows a detail view of a cell frame in accordance with another embodiment of the invention.

Figure 1 shows a pressure electrolyzer, which is labeled as a whole by reference number 1, and in which an electrolytic cell block 3 is mounted in a pressure tank 2. The electrolytic cell block 3 consists of a number of electrolytic cells 4 arranged in a stack. Each electrolytic cell comprises an anode 11 and a cathode 12, which are separated from each other by a diaphragm 13 arranged between them. Between two adjacent electrolytic cells 4, there is a bipolar separator 14, by which the anode compartment of one electrolytic cell 4 is separated from the cathode compartment of the adjacent electrolytic cell 4, while at the same time electrical contact between the two is maintained. End plates 21, 22 are provided at the ends of the electrolytic cell block 3, namely, an end plate 21 at the anode end and an end plate 22 at the cathode end. The end plates 21, 22 hold the electrolytic cell block 3 in its longitudinal direction under mechanical pretensioning with the individual electrolytic cells 4 sealed from one another. In addition, the end plates 21, 22 form the terminal seal of the pressure tank 2. Finally, the end plates 21, 22 serve to supply electric power to the electrolytic cell block 3. The power is supplied through a power supply line 23 at the anode end and a power supply line 24 at the cathode end. Electrical insulation 31, 32, 33 is arranged on the end plates 21, 22 and on the inside of the pressure tank 2. The housing 5 of the electrolytic cell block 3 is formed by a number of stacked cell frames 15,

16; 25, 26 of the electrolytic cells 4. In the embodiment shown in Figure 1, each anode 11 is provided with its own adjacent anode cell frame 15; 25, and each cathode 12 is provided with its own adjacent cathode cell frame 16; 26.

As is shown in Figures 2 and 3, which represent two different embodiments of the cell frames 15, 16 and 25, 26, respectively, the cell frames 15, 16; 25, 26 consist at least partially of an elastic material 15a, 16a and 25a, 26a, respectively, which is elastic at least in the longitudinal direction and the transverse direction of the electrolytic cell block 3. This elastic material 15a, 16a and 25a, 26a, respectively, seals adjacent cell frames 15, 16 and 25, 26, respectively, from each other, and the elastic material 15a, 16a and 25a, 26a, respectively, is compressed in the longitudinal direction, which causes the electrolytic cell block 3 to be held in place between the end plates 21, 22, as Figure 1 shows. Besides sealing adjacent cell frames 15, 16 and 25, 26, respectively, from each other, the compressibility of the elastic material 15a, 16a and 25a, 26a, respectively, compensates thermal expansion or contraction during the startup, operation and shutdown of the pressure electrolyzer and also compensates dimensional tolerances of the individual cell frames 15, 16 and 25, 26, respectively. The cell frames 15, 16 and 25, 26, respectively, additionally comprise a rigid element 15b, 16b and 25b, 26b, respectively, which runs in the circumferential direction of the frame, mechanically stabilizes the cell frames 15, 16 and 25, 26, respectively, and is connected with the elastic material 15a, 16a and 25a, 26a, respectively.

In the embodiment illustrated in Figure 2, the rigid element 15b, 16b forms a shell-like frame structure, which partially encloses the elastic material 15a, 16a and from which the elastic material 15a, 16a partially protrudes to form a compressible region 15c, 16c in the longitudinal direction of the electrolytic cell block 3. The elastic material 15a, 16a can thus be placed under

compression between the rigid element 15b, 16b in which it is embedded and the rigid element 15b, 16b of the adjacent cell frame 15, 16, so that it can carry out the aforementioned functions of sealing adjacent cell frames 15, 16 and compensating thermal expansion.

In the embodiment illustrated in Figure 3, the rigid element 25b, 26b forms a frame-like insert that is embedded in the elastic material 25a, 26a of the respective cell frame 25 and 26.

As Figure 2 shows, the adjacent cell frames 15, 16 have projecting parts 15d, 16d and recesses 15e, 16e that fit into each other and serve to lock the adjacent cell frames 15, 16 in place and/or seal the adjacent cell frames 15, 16. For example, cell frame 15, specifically, its shell-like rigid element 15b, has a projection 15d, which fits into a recess 16e of the adjacent cell frame 16, specifically, a recess 16e in the elastic material 16a of the adjacent cell frame 16. Similarly, cell frame 16, specifically, its shell-like rigid element 16b, has a projection 16d, which fits into a recess 15e of the following adjacent cell frame 15, specifically, a recess 15e in the elastic material 15a of the adjacent cell frame 15.

In both of the embodiments shown in Figures 2 and 3, each anode 11 is assigned its own anode cell frame 15 and 25, respectively, and each cathode 12 is assigned its own cathode cell frame 16 and 26, respectively.

In the embodiment shown in Figure 2, peripheral slits 111, 112, which receive the anode 11 and the cathode 12, respectively, are formed in the elastic material 16a of cell frame 16, which in the present case is referred to as the cathode cell frame. A peripheral slit 114, which receives the bipolar separator 14, is formed in the elastic material 15a of cell frame 15, which in the present case is referred to as the anode cell frame. Although the slits 111, 112 are thus provided for both the anode 11 and the cathode 12 in the elastic material 16a of the cathode cell frame 16, cell frame 15 should be regarded as assigned to the anode, and cell frame 16 should be

regarded as assigned to the cathode, which is repeated for each electrolytic cell 4. The peripheral slits 111, 112, 114 in the elastic material 15a and 16a allow dimensionally stable, tight and positionally stable holding of the anode 11, cathode 12 and bipolar collector 14 without any additional measures. This also applies to a diaphragm contained in the electrolytic cells. For the sake of simplicity, however, the diaphragm is not shown in Figure 2.

In the embodiment shown in Figure 3, peripheral slits 211 and 213, which receive the anode 11 and the diaphragm 13, respectively, are again formed in the elastic material 25a of cell frame 25, which is referred to here as the anode cell frame. In contrast to Figure 2, in Figure 3 the diaphragm 13 is explicitly shown. In addition, a peripheral recess 212, which receives the cathode 12, is formed on the side of the elastic material 25a that faces the elastic material 26a of the adjacent cell frame 26a. The elastic material 26a of the adjacent cell frame 26, which is referred to here as the cathode cell frame, contains a recess 214 for receiving the bipolar separator 14 on its side facing the cell frame 25 of the following electrolytic cell 4. Here again, the anode 11 and the cathode 12 each has its own cell frame, namely, anode cell frame 25 and cathode cell frame 26, which is repeated for each electrolytic cell. The peripheral slits 211, 213 and the peripheral recesses 212, 214 allow the respective elements, namely the anode 11, the diaphragm 13, the cathode 12 and the bipolar separator 14, to be held in the cell frames 25, 26 in a dimensionally stable, tight and positionally stable way, so that no additional measures are required for this.

The elastic materials 15a, 16a and 25a, 26a of the respective cell frames 15, 16 and 25, 26 can consist of an elastomer or a soft elastic thermoplastic.

The rigid elements 15b, 16b and 25b, 26b of the respective cell frames 15, 16 and 25, 26 can consist of a dimensionally stable material, especially a metal, another suitable metal, or a

plastic.

In the embodiment shown in Figure 2, the rigid element 15b, 16b that forms the shell-like frame structure consists especially of an electrically insulating material, especially plastic.

The surfaces of the components of the cell frames 15, 16 and 25, 26 that are continually acted upon by the gas-containing media present in the pressure electrolyzer 1 can be sheathed in a suitable coating, e.g., PTFE, as additional protection and as a means of reducing flammability.

The shape of the cell frames 15, 16 and 25, 26 can be adapted to the interior of the pressure tank 2 in such a way that they not only fulfill their function of forming the housing 5 of the electrolytic cell block 3 but also serve as a support structure for the electrolytic cell block 3.

As Figure 4 shows, flow obstacles 300 formed by serrations 310 can be provided on the upper surface of the upper frame pieces of the cell frames 15, 16 and 25, 26 to improve the gas separation effect.



### List of Reference Numbers

1	pressure electrolyzer
2	pressure tank
3	electrolytic cell block
4	electrolytic cells
5	housing
11	anode
12	cathode
13	diaphragm
14	bipolar separator
15; 25	anode cell frame
15a; 25a	elastic material
15b; 25b	rigid element
15c	compressible region
15d	projection
15e	recess
16; 26	cathode cell frame
16a; 26a	elastic material
16b; 26b	rigid element
16c	compressible region
16d	projection
16e	recess
21, 22	end plate

23, 24	power supply line
31	electrical insulation
32	electrical insulation
33	electrical insulation
111	slit
112	slit
114	slit
211	slit
212	recess
213	slit
214	recess
300	flow obstacle
310	serration